Volcanism Framework for Probability Calculations

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We completed volcanism research for the YMP in 1996. Our work included site characterization studies and calculations to estimate the probability of disruption of the proposed Yucca Mountain repository. Our results—that the probability of disruption of the repository in the next 10,000 years is 10^{-8} per year—were confirmed by a DOE-sponsored expert elicitation panel, composed of 10 leading independent volcanologists.

In 1999, we were asked to conduct additional research to provide regulatory support for the YMP Site Recommendation Report and the YMP License Application. During this period, we developed and documented an integrated conceptual model of volcanism. We then collaborated in generating revised probability models that account for the recent changes in repository design and recent advances in understanding of the tectonic and volcanic setting of Yucca Mountain.

Field Studies at Yucca Mountain

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Field studies at the potential high-level radioactive waste repository at Yucca Mountain, Nevada, range from surface boreholes drilled into the mountain to elaborate underground test facilities. These studies have characterized the mountain's lithostratigraphy, mineralogy, and hydrologic properties and provided on-site field testing of, for example, the thermal-mechanical properties of the rock and radionuclide transport in the unsaturated zone. This project is discussed in detail in the Research Highlights section.

Managing YMP Facilities and Data

The Engineered Barrier System (EBS) Field Testing Program

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There are several field tests being conducted at Yucca Mountain to test engineered, as opposed to natural, barriers. Formally termed the engineered barrier system, the EBS includes any component installed between the emplacement drift wall and the waste package that would enhance the performance of the overall emplacement system. For example, the EBS could be enhanced by diverting water away from the waste package, disposing of the diverted water from the EBS environment, or maintaining an overall benign environment for the waste package. The EBS field-testing program includes a variety of experiments, from bench-top to quarter-scale. Four field-test activities are presently underway: (1) testing of soil properties in a laboratory environment, (2) a small-scale thermal-hydrological-chemical test, (3) 1.4-m-diameter thermal tests on various drip shield and backfill concepts, and (4) construction of a 40-m-long thermal/ventilation experiment. Unlike most other field tests at Yucca Mountain, the EBS tests are conducted at a DOE facility in North Las Vegas, 90 miles from the Yucca Mountain site. This location and unique test arrangements make for some distinctive test coordination challenges. As is in place for tests near Yucca Mountain, the Test Coordination Office plans and coordinates the EBS work under a fully qualified DOE Quality Assurance Program. The staff prepares field-work packages for the following: (1) facility-design/construction interface, (2) management roles and responsibilities during a test, (3) test requirements, (4) ES&H controls, and (5) budget and schedules.

The Underground Field Testing Program

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Field testing, an important component of YMP site research, is a way for scientists to test their theories at analog sites in the Yucca Mountain area and elsewhere. Our team coordinates all underground field-testing activities at two major sites in the Yucca Mountain area, the Exploratory Studies Facility (ESF) and the Unsaturated Zone Testing Facility at Busted Butte. The 7.8-km- and 2.8-km-long tunnels at the ESF have eight testing alcoves and five test niches in which scientists conduct research on moisture monitoring, air permeability, liquid permeability, percolation, and seepage. There is also a large thermal test facility at the ESF at which tests are conducted. The testing facility at Busted Butte is a mined underground test area similar to geologic units located below the potential repository horizon. Scientists there have conducted flow and transport tests at Busted Butte since April 1998. Our staff is on location at both field-test sites daily, working with construction, engineering, and scientific staff to solve problems and facilitate all activities.

Managing Data at the Test Coordination Office (TCO)

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The TCO operates several large data collection systems for the YMP, the largest monitoring the heated Drift Scale Test (DST) in the Exploratory Studies Facility. The DST produces 18 megabytes of data daily, which is fed in from 3,800 sensors. We also record data from the EBS tests at the North Las Vegas facility.

We recently installed fiber-optic cables throughout both facilities. Using, specially designed diagnostic equipment, we continually monitor the system's status, and an auto-dialer at the site immediately notifies our staff of problems. After more than two years of operation, only a few hours of data have failed to be recorded.

We have also developed qualified software to automate calculations, electronically transfer data to our office, verify data, and generate documentation for these tasks. The TCO is operated under a strict DOE-mandated quality assurance program, continually developing processes to remain compliant with new procedures.

Managing the Busted Butte Unsaturated-Zone Transport Test (UZTT)

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The Busted Butte UZTT is designed to further understand the role of the Calico Hills formation as a barrier to radionuclide migration in the unsaturated-zone at Yucca Mountain. The test is designed to validate and continuously improve the unsaturated zone flow and transport site-scale model. For this purpose, the test block has been located at Busted Butte, an area in which the exposure of Calico Hills rocks represents a distal extension of the formation located immediately beneath the potential repository horizon. This location means that the site is not an analog site, but represents both the vitric Calico Hills Formation and the Topopah Spring Tuff units as they exist beneath the potential repository horizon west of the Ghost Dance fault.

So far, the following overall conclusions may be drawn from the Busted Butte UZTT: (1) porous media flow dominates in the vitric Calico Hills; (2) preliminary results indicate sorption onto smectite is potentially beneficial to repository performance; (3) measured sorption values for Busted Butte (vitric) rocks are greater than are currently used in models, which is positive for performance calculations in that they are truly conservative. Results from the test will continue to be used as part of the basis for the Site Recommendation and the License Application.

Contributions to the YMP Site Description

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Over the past two years, the YMP program emphasis has changed from characterizing the site of the potential repository to preparing scientific reports describing our present state of integrated scientific knowledge of the site and the surrounding region. The information presented in Los Alamos Analysis Model Reports is being included in Process Model Reports, which are being incorporated in the "Yucca Mountain Project Site Description," a comprehensive document that discusses all aspects of YMP scientific research, on a national level. The Site Description is intended first to serve as the scientific basis for the "Site Recommendation Consideration Report" and ultimately for the "License Application." Los Alamos has lead responsibility in the Site Description for the sections on geochemistry, volcanic geology, and surface processes.

Quality Assurance

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Quality assurance, also known as technical assurance, is major component of the Los Alamos YMP effort and is governed by the DOE quality assurance program. Our quality assurance staff supports YMP researchers' training, document control, record and data administration, and software certification. In addition, we help principal investigators prepare for external audits, and we review all documents for quality assurance concerns. As repository licensing draws closer, the DOE has made quality assurance for YMP a high priority, stating that scientific findings will not be accepted without the proper quality assurance pedigree—this makes our team's work a crucial component in the research process. Much of our responsibility centers on establishing "traceability," in which we review and verify the entire research process, beginning with initial experiments and progressing to the paper describing final results.